



A PRACTICAL GUIDE TO RESPONSIBLE RESEARCH AND INNOVATION

KEY LESSONS FROM RRI TOOLS

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INTRODUCTION

Responsibility in science and technology is a hot topic among the policy-makers, researchers and innovators of Europe. Thanks to concerted efforts in recent years, more people now understand the changes that the European research and development system is going through. More citizens are involved in science through public engagement exercises. Natural scientists and social scientists have formed collaborations. Users are leading innovation. Open access trends are changing the publishing system. Gender equality has rightly gained political momentum. Together, these efforts form a European-wide approach called Responsible Research and Innovation (RRI).

RRI is a cross-cutting issue within the Horizon 2020 funding scheme — the EU's biggest ever Research and Innovation programme — and in line with [Europe 2020](#) - the EU's strategy for growth launched in 2010, including specific targets for research and development. The launch of RRI also follows the 2009 [Lund Declaration](#) (updated in 2015), which called upon European nations and institutions to focus research on the 'grand challenges' facing society, such as climate change, water shortages and ageing populations. RRI can also be found in Europe's emerging policy of 'Open Innovation, Open Science and Open to the World' ([explained on page 57](#)). These three goals will frame research and innovation policy in the EU

in years to come and are in many ways based on RRI principles.

To foster the development of RRI across Europe, in 2014 the Commission funded the RRI Tools project. This three-year project has involved over 25 different institutions across 30 countries and set out to create a Toolkit ([page 33](#)) – a universal point of call for policymakers, researchers, industries, civil society organisations and educators on questions of RRI.

This quick guide explains what responsible research and innovation really means and why it is so important for modern society. It explores RRI through the lens of the RRI Tools project and provides practical examples of its implementation through a number of case studies ([page 15](#)) and an overview of the RRI Toolkit structure and main contents ([page 33](#)). A selection of 'How To' guidelines ([page 37](#)) explains how to apply RRI to specific situations, including policy, research and business contexts. Finally, this guide provides five recommendations ([page 51](#)) that can help to make all types of research and innovation more responsible.

This document explains how RRI Tools has laid the groundwork for more responsible, acceptable, and ethical science and technology development in Europe — in the pursuit of a better, more sustainable and more equitable world.

The RRI Tools team



SHAPING THE FUTURE: A RESPONSIBLE RESEARCH AND INNOVATION POLICY BRIEF

Science has changed the world and continues to be a driving force for humanity's progress. No one could question the fact that science and technology have improved quality of life for many of us, but in some cases innovation has led to controversial or unintended consequences.

Global warming for example — one of the biggest challenges facing modern society — has been driven by human activities. There are more nuanced examples of innovations that originally served a valuable purpose but had later negative consequences: asbestos and lung disease; CFCs and the ozone layer; and pesticides and biodiversity loss to name a few. As the European Environment Agency puts it, 'the growing innovative powers of science seem to be outstripping its ability to predict the consequences of its applications'.

And society today is facing some colossal issues — such as food security, antibiotic

resistance and energy supply — so it is important that science continues to progress. These issues need to be tackled, but in the right way; conducting research that not only answers questions and solves problems, but is also in line with the ethical values and needs of society.

Achieving this requires reflection on complex ethical issues and their potential risks, however unlikely they may be. It is also important to involve wider society in these discussions through open and transparent processes that can be flexibly adapted to rising demands and ensure a diversity of voices is considered. This is where Responsible Research and Innovation (RRI) comes into play.

RRI aims to engage a broad range of stakeholders to discuss how science and technology can be used in the best possible way to not only contribute to solve today's problems, but also create a world that will be desirable for future generations.

WHAT IS RRI?

The term RRI was pioneered in the 2000s. Broadly speaking, RRI is a process of research and development that considers scientific enquiry in a wider context — not just from the perspective within the lab, but also from the natural environment and society's viewpoint. Fundamentally, it is about creating high quality science that is more in the public interest.

To make RRI easier to understand and discuss, RRI Tools built on previous efforts to develop a working definition of the term:

Responsible Research and Innovation is a dynamic, iterative process in which all stakeholders in research and innovation become mutually responsive and share responsibility for both the process and its outcomes.

This means the focus is not only on achieving socially desired outcomes, but also on how the research and innovation (R&I) that leads to them is conducted and on those involved in this process. RRI can thus be broken down into four key elements: outcomes, process dimensions, policy agendas and stakeholders.

RRI IS ABOUT: INCLUDING ALL ACTORS, AND CONSIDERING SPECIFIC KEY ISSUES AND THE R&I PROCESS DIMENSIONS



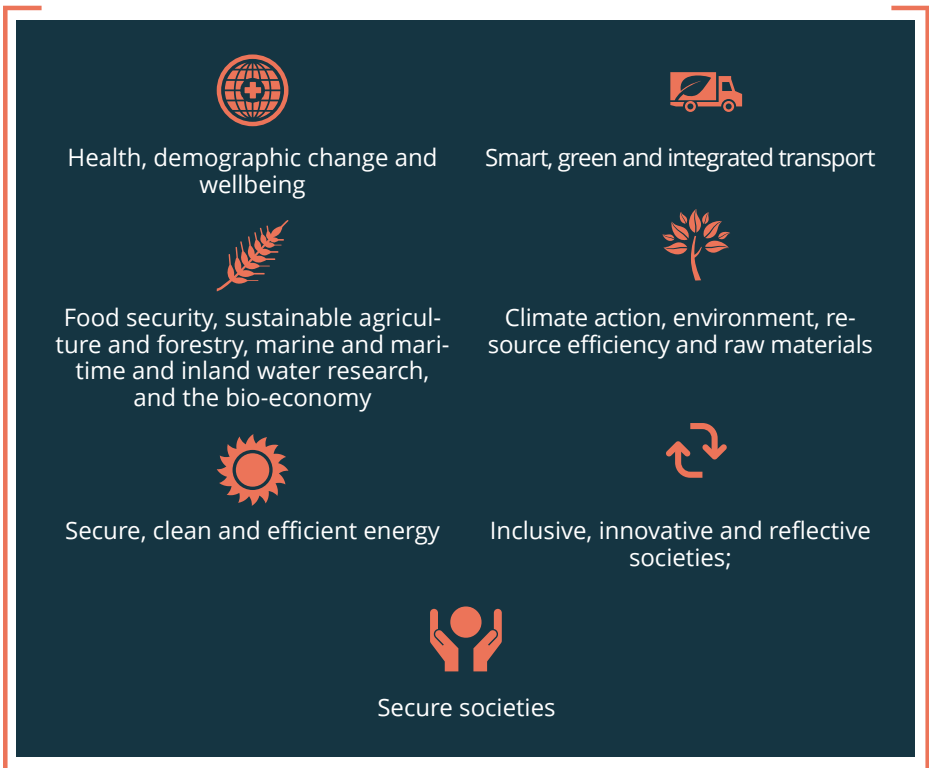
OUTCOMES OF RRI

Implementing RRI has a number of beneficial outcomes.

Firstly, RRI contributes to create **more engaged public, responsible actors and responsible institutions**. RRI leads to empowered and responsible individuals across all elements of research and innovation, from individual researchers and innovators to policymakers, educators and society at large. This is supported through large-scale organisational change, which ensures RRI is an enduring phenomenon.

Secondly, RRI has clear benefits for **research and innovation**, making science and technology **more ethical, sustainable and socially beneficial**. RRI is about striving to include more voices in research and development and making adaptive changes to achieve this. In doing so, RRI generates outcomes that are ethically acceptable, sustainable and more useful to society in the long-term.

Thus, RRI contributes to generate better solutions to **societal challenges**, such as the seven grand challenges articulated by the European Commission:



PROCESS DIMENSIONS

To achieve these outcomes, the research and innovation process should be:



DIVERSE AND INCLUSIVE

To produce outcomes that align with the values and expectations of society, all of the groups involved in and affected by research and innovation need to work together. Voices across a diversity of communities should be involved in research, from its beginnings to its commercialisation. Different perspectives and expertise generate higher quality science and ensure all points of view are taken into account.



OPEN AND TRANSPARENT

RRI is also about achieving a more knowledge-based society. This means making the process of research and innovation more transparent and open to all actors, providing them with meaningful information during all stages of the process. This encourages all actors and the public to engage with, discuss and scrutinise science and technology, which empowers people to make more informed decisions.



ANTICIPATIVE AND REFLECTIVE

Responsible actors consider not just the immediate impacts of their work, but look ahead and reflect on the kind of future they are trying to build. This means considering why this is a desirable future, how it will be achieved, and any possible unintended consequences that may arise along the way. Anticipating the possible impacts and reflecting on the underlying assumptions, values and purposes of research and innovation generate useful insights that allow more responsible action.



RESPONSIVE AND ADAPTIVE TO CHANGE

Finally, research and innovation must respond to the views expressed by the public and other stakeholders and, if necessary, methods or goals should be changed. The ability to adapt as a result of different views, changing circumstances or fresh knowledge is the final process dimension of RRI.

What does this mean for policymakers?

Policy is essential to support RRI. To help embed RRI in the research and development process, the European Commission has set out six key themes for policymakers to consider:



ETHICS AND RESEARCH INTEGRITY

Research, including its outcomes and the way it is conducted, should be morally grounded and acceptable to society. Honesty, accountability, fairness and good stewardship should be core principles of research and innovation.



GENDER EQUALITY

Considering the perspectives of both men and women in research and innovation means its outcomes are relevant to the whole population — not just half of it! Teams and decision-making bodies should thus have balanced gender representations. Additionally, gender needs to be considered as part of the R&I process and content itself to provide results that are useful for all citizens.



GOVERNANCE

RRI principles should be embedded in robust governance arrangements. Such a framework should be in line with existing practices but also flexible and able to adapt to changes, as research and innovation can be unpredictable.



OPEN ACCESS

Much of scientific research is costly to access, despite being most of it publicly funded. Open access science has many benefits: encouraging collaborations, catalysing innovation, and ultimately improving the quality of research. Scientific results and data should thus follow the FAIR principle (Findable, Accessible, Interoperable, Reusable).



PUBLIC ENGAGEMENT

Involving stakeholders and the public in the processes of research and innovation helps to ensure that the results match the values, needs and expectations of society. This involvement needs to take place as upstream in the process as possible, to avoid backlash of results and reducing engagement to mere tokenism.



SCIENCE EDUCATION

The demand for highly qualified people in the European Union is expected to [rise significantly in the coming years](#). Improved science teaching could promote research as a career and provide citizens with the knowledge and skills they need to take part in discussions and decisions on research and innovation.

STAKEHOLDERS

WHO ARE THE INTERESTED PARTIES IN RESEARCH AND INNOVATION?

Modern society is strongly based on scientific and technological developments. It is thus essential that research and innovation are conducted through a permanent dialogue between all actors, such as:



Policymakers

This refers to policy officers, research centre directors and funders. Really it includes anyone who makes decisions about the shape of research and innovation — whether locally, nationally or internationally.



Education community

Those concerned with education — from primary school to university — including teachers, students, families, and science centres and museum staff.



Research community

This covers researchers, research managers and everyone involved in the research and innovation system, such as science communicators, research technicians and other support staff.



Business and industry

RRI is relevant to any business with research and innovation at its foundation, from SMEs to transnational companies, including networks, incubator hubs, and other supporting organisations.



Civil society organisations

This diverse group includes individuals and organisations, such as trade unions, NGOs and the media. All members of civil society are critical to shaping research and innovation.

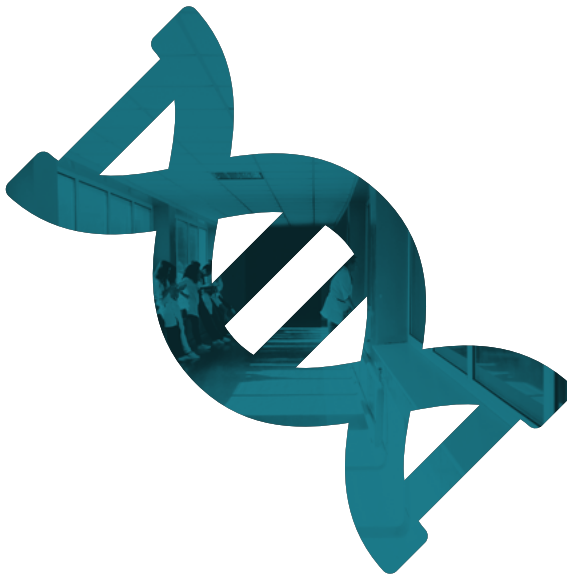
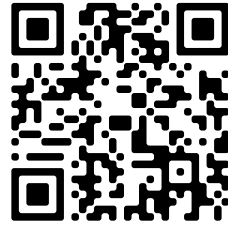
IN A NUTSHELL

It is the duty of all science and technology decision makers, researchers and innovators to act responsibly to ensure their work does no harm. But RRI goes beyond this, to strive for a shared responsibility on research and innovation that does good—addressing the key issues facing society in an ethically and environmentally aware manner.

To achieve this on a large scale, RRI needs to be a systematic procedure throughout the R&I process, from agenda setting and policy design to the evaluation of results and careers.

Most importantly though, uptake of RRI should be increased among those who must implement it: funding bodies and R&I-performing institutions and individuals. Many already practice responsible conducts in some form, but

it is important that even researchers in basic science also engage with society and consider the wider impacts of their work. The ideas behind RRI may be easy enough to understand, but implementing them can be difficult. The challenge therefore is not only to make sure the research and innovation community understands the aims of RRI, but also how to make it reality. The following sections aim at helping all actors to start their journey towards a more responsible practice of research and innovation.





LEARNING FROM EXAMPLE: RRI SHOWCASES

The principles of RRI may be straightforward enough to grasp in theory, but these principles need to be translated to the real world. To bring the concept to life, RRI Tools has put together eight showcases that exemplify how RRI can be applied in practice.

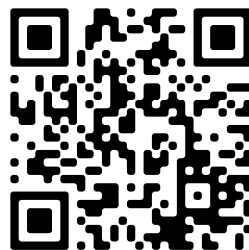
Some of these examples come from the business world, such as UK company **Hao2**, which works to develop novel solutions that empower people on the autism spectrum to find employment. Others take a more tailored guidance approach; the **Social Innovation Factory** provides financial support, markets and other efforts to expand projects. Some represent change initiated at a policy level such as the government-funded Knowledge for Climate Programme, which brought together researchers, businesses and citizens to understand climate change. Others describe changes made by funding bodies, such as the **Swedish Innovation Agency**, which has developed a novel approach to funding based around societal challenges.

These case studies also describe solutions to a wide range of problems, from

overfishing and climate change to the growing burden of disease in emerging economies, the difficulties faced by start-up businesses and the growing lack of scientific vocations among kids.

The showcases form part of the RRI Toolkit set of training resources, and are accompanied by activities to help those new to RRI. They each include an introduction to explain the case study's RRI importance, the showcase's story, training exercises and useful resources.

This section briefly reviews each of the showcases, highlighting their main achievements and relevance to RRI. Their full detail can be found on the RRI Toolkit at www.rri-tools.eu/training/resources.





IPMA: A PORTUGUESE FLEET AGAINST OVERFISHING

The efforts of the Portuguese Sea and Atmosphere Institute (IPMA) provide an excellent example of how to involve stakeholders in research. The IPMA, a public institution in Portugal, is a state laboratory that promotes and coordinates marine research. Through a range of research projects, it provides information to policymakers to make resource consumption more sustainable and improve ecosystems' health.

Recently, marine researchers from IPMA turned their attention to the lack of fisheries data. Over 90 percent of the Earth's fisheries do not have sufficient data on the numbers and species they contain. This can lead to overfishing, which affects over 85 percent of the world's fisheries. Overfishing reduces biodiversity and also has implications for the millions of people who rely on fish as a source of protein and livelihood. Without adequate knowledge of how many fish there are in an area, it is difficult to make the right decisions on management, and fishers may unwittingly strip an area of a key species.

The research team focused on black scabbardfish, which is commonplace in many Southern European diets. However, fishing of the black scabbardfish poses a threat to deep water sharks, which can accidentally be caught alongside them, often comprising as much as 15 percent of a catch.

In 2010, the EU banned this practice completely. Yet, instead of stopping sharks from being caught, fishers simply stopped reporting the forbidden by-catch and started returning the dead sharks to the sea. This under-reporting means the gov-

ernment doesn't know where sharks are most likely to be caught or are most vulnerable, hampering conservation efforts.

A group of key stakeholders was brought together, including marine researchers, fishers and policymakers, to solve this problem. The organisation used state-of-the-art techniques to gather their opinions and experience over a period of two years. Stakeholders were involved in all stages of the research — from agenda setting to the final follow-up — to ensure the research answered all the important issues, delivered outcomes that were accessible and user-friendly, and made practical recommendations.

As a result, a scientific paper (co-authored by multiple stakeholders) was published. In the same year, a multi-stakeholder meeting was held, leading to a final consensus. All stakeholders agreed to work on a collaborative proposal to policymakers, recommending that they allow a very small shark by-catch, as well as the definition of specific protected areas. Such a system would still deliver enough fish to maintain the livelihood of local fishers, without having such an adverse impact on sharks. Allowing just a small percentage of the catch to be landed and therefore monitored will also enable more effective decision-making, providing the data to show where sharks are most at-risk and where catch limits are needed.

This showcase describes methods for stakeholder engagement, challenges and opportunities provided by participatory research, which could be useful for other RRI projects.

EPSRC: PUTTING RRI IN SIMPLE TERMS

RRI is critically important in the fields of science and technology that are most likely to have a significant impact on society — not least is engineering where there are so many hot topics for RRI to tackle.

Nanomaterials is an example of this. The use of functional materials made from tiny particles is rapidly being deployed across the electronics, healthcare and cosmetics markets. Synthetic biology, which aims to re-design cellular structures to produce fuels and pharmaceuticals, is also another area of interest for RRI.

The Engineering and Physical Sciences Research Council (EPSRC) in the UK invests over €970 (£800) million every year in such research. The council is committed to promoting RRI through its funding to ensure that research is carried out in an ethical and responsible manner.

As part of this commitment, in 2012 the EPSRC published a Framework for Responsible Innovation (<https://www.epsrc.ac.uk/research/framework/>). The core part of it, summarised in the box below, was developed to help researchers consider the societal issues surrounding their work.





The AREA Code

ANTICIPATE – consider the possible economic, social and environmental impacts of the research.

ENGAGE – conduct discussions with many different stakeholders.

REFLECT – reflect on the reasons for doing the research, and any possible uncertainties, biases or problems.

ACT – use these processes to influence the research and innovation process.

Importantly, the EPSRC recognised that some researchers are already engaged with RRI and that different research fields may require different approaches. The framework is thus a flexible, not prescriptive, approach. This attitude has helped to encourage the adoption of RRI principles.

This process has already resulted in a call for synthetic biology research proposals in 2013. This led to several research centres being funded, many of which had specific commitments to responsible innovation. [SynbiCITE](#) for example,

a centre that encourages industry to use synthetic biology has explicitly adopted responsible innovation as part of its way of working, developing its own approach to RRI based on the EPSRC's recommendations.

The EPSRC shows that funders can react positively to public concerns to create more ethical, socially relevant and ultimately impactful science. Further, the framework is widely applicable and could provide lessons and inspiration for other funding agencies.



HAO2: UNIQUE TRAINING FOR THE WORKPLACE

Hao2, a social business that develops 3D virtual environments, is an excellent example of inclusive innovation and how to operate as a responsible business. This UK-based company provides opportunities for those on the autism spectrum and other complex needs.

Those with autism (over 21 million worldwide) can find it difficult to make their way in the world of work and often face significant barriers to employment. According to the National Autistic Society, only 15 percent of adults with autism have a full-time job.

Hao2's CEO Nikki Herbertson observed that using technology could be a solution to this difficult social problem by reducing barriers to engagement and communication. So, in 2010, Hao2 started to develop 3D virtual learning platforms, where those on the spectrum can receive training for situations they may find difficult.

Crucially, Herbertson recognised that the only people who could provide the insight really needed were people with autism themselves. Over 80 percent of the workforce at Hao2 are on the spectrum and are actively involved in the design of the products.

Through Hao2's innovative technology, people with autism can receive training to prepare for employment and improve their communication skills and, critically,

HAO2 HAS WON NUMEROUS AWARDS FOR ITS WORK, INCLUDING THE CBI/NOMINET TRUST MOST INNOVATIVE INTERNET BUSINESS. IN LESS THAN 10 YEARS, THE COMPANY HAS GROWN FROM A SMALL START-UP INTO A SUCCESSFUL BUSINESS WITH CONTRACTS AROUND THE WORLD

their confidence. The programmes have 100 percent completion rates and over half of participants move into employment or volunteering afterwards.

Not only socially responsible, the business has also been extremely successful. Hao2 has won numerous awards for its work, including [the CBI/Nominet Trust Most Innovative Internet Business](#). In less than 10 years, the company has grown from a small start-up into a successful business with contracts around the world — including the UK's National Health Service, government departments and universities. This case demonstrates several RRI principles including diversity, inclusion, engagement, responsiveness and outcomes that meet the needs of society. It also shows that companies can both be responsible and successful.



NOVO NORDISK: THE TRIPLE BOTTOM LINE PRINCIPLE FIGHTING DIABETES

Novo Nordisk is a global healthcare company headquartered in Denmark that offers another example of a company operating responsibly to the benefit of both itself and society.

A key element of Novo Nordisk's values is the so-called 'Triple Bottom Line'. This system is based on the belief that a healthy economy, environment and society are important for long-term business success and is formalised in the company's regulations.

The Blueprint for Change case study focuses on the company's efforts to tackle diabetes in Indonesia. Like several emerging economies in Southeast Asia, Indonesia has experienced improving standards of living, unfortunately accompanied by a growing diabetes epidemic. There are an estimated 8.6 million people in the country with diabetes. Less than half (3.9 million) are aware of it and even fewer (3.7 million) are receiving treatment. Of greatest concern, less than 1 percent achieves treatment targets.

The reasons for this are many; low public awareness of the condition, a lack of specialists (just 64 for the whole country) and strained hospitals with scant resources and untrained doctors. As a result, seven out of every ten people with diabetes in Indonesia develop complications that affect their quality of life and could even be fatal.

To improve access to care, Novo Nordisk established a number of initiatives

in Indonesia, including the [Inspire Training Programme](#), developed in collaboration with the Indonesian Society for Endocrinology. Over 5,000 doctors have been trained through this programme, which has increased diabetes knowledge among hospital and local doctors. By providing doctors with new skills and the confidence to deal with diabetes, trust has increased among patients, encouraging them to go to their doctor believing they will receive the right treatment and information on how to manage their condition.

This case demonstrates how 'shared values' can be a strategy for success. Society's needs define the markets and doing business in a way that benefits society can also be profitable. Addressing societal needs through business solutions creates value for society (in this case by improving access and quality of treatments) and for business — more patients now have access to Novo Nordisk's treatments and the company's reputation has been bolstered.

Novo Nordisk case demonstrates the central RRI principles of diversity and inclusivity (considering the needs of patients and care providers), transparency (openly communicating the Triple Bottom Line principle), and responsiveness (adapting its strategies according to local needs and cultures).

Using RRI principles in business can promote sustainability and social responsibility without compromising profits; lessons that could be used to help other businesses create shared value.



KNOWLEDGE FOR CLIMATE: PREPARING FOR THE CHANGING FUTURE, TOGETHER

Climate change is one of the biggest challenges facing humanity, placing unprecedented pressure on human and natural systems. Its risks include rising temperatures and flooding, which can have huge social and economic impacts.

To understand and communicate these risks in the Netherlands — a low-lying country at high risk of flooding — the

KVK FOCUSED ON ADAPTING TO THE NEW CONDITIONS BROUGHT ABOUT BY CLIMATE CHANGE, IN ORDER TO 'CLIMATE PROOF' THE NETHERLANDS

Knowledge for Climate (KvK) programme was established. This government-funded research programme focused on the possible effects of climate change

in the country and involved active collaboration between the Dutch government, scientific community, businesses and civil society organisations.

KvK focused on adapting to the new conditions brought about by climate change, in order to 'climate proof' the Netherlands. A major element of the project was to address 'hotspots,' areas in the country that scientists and policymakers have designated to be particularly vulnerable to climate change. Teams made up of representatives from water authorities, municipalities and universities were assembled, which led to tailored adaptation strategies for each area.

The knowledge gained by the project was soon put to practical use. It helped governments and businesses to make informed decisions about planning and investment. One notable outcome of the project was 'supersafe dykes', which are wider and heavier than conventional flood prevention systems. This means water can flow over the embankment, but not break it, which reduces the damage to surrounding areas.

This case provides an excellent example of how to achieve successful collaboration between science, industry and government. By applying the key principles of RRI — such as focusing on major problems and applying continued engagement — the programme made a real difference; the knowledge gained by the project helped policymakers make decisions to protect the country from flooding, which could one day save lives.



SOCIAL INNOVATION FACTORY: SUPPORTING BOTTOM-UP INNOVATION

The previous case is one of a multitude of government-funded projects working on society's big challenges. However, there are also many less recognised social initiatives working to find solutions to these problems. In many cases, these small initiatives struggle to find the funding and support to make their ideas reality.

To change this, the Social Innovation Factory provides free support and guidance to these initiatives. This Belgium-based

network of civil society organisations and social entrepreneurs is founded on the belief that individuals, businesses and organisations have the potential to create solutions to major challenges, including poverty, climate change and the ageing population. The Factory helps social innovators and entrepreneurs to overcome barriers to success, including upscaling, finding partners and creating a business model. The Factory supports over 120 entrepreneurs and small businesses each year.



Tejo: A Social Innovation Factory success story

The Social Innovation Factory does not provide a fixed model of support, but rather tailored guidance. In the case of TEJO, which provides free and anonymous psychological support to young people at six centres across Belgium, the Factory provided financial support and promotion, helping to expand the project without compromising its mission or identity.

TEJO provides fast, anonymous and free of charge support to young people struggling with psychological stress, as an alternative to the long waiting lists at official mental health centres.

The project has already helped more than 2,500 people in over 10,000 separate appointments at its Antwerp headquarters. <http://www.tejo.be>

A key part of the Factory's process is evaluation, which includes assessing the social impact of the idea: is it socially inclusive and desirable, and who is it likely to benefit? How important is the solution? Does it tackle a really significant issue? The Factory will also assess practical aspects, such as whether the idea is scalable, how the costs might be covered, and whether partners are needed. This helps to ensure the project will be successful, sustainable and of benefit to society.

The Factory offers several tools to support innovators and their projects, including boot camps, one-on-one sessions and access to research and funding opportunities. It also helps to put innovators in touch with partners.

Those who are helped by the organisation in turn share their knowledge and expertise to help others realise their ideas. This peer-to-peer network ena-

bles cross-sectoral learning and collaboration between people with a diversity of experience and backgrounds.

Although only established in 2013, the organisation has already helped over 8,000 people. And the financial returns are significant; for every euro the Factory received in government funding, it generated over three in private funding for social innovation. The work of the Social Innovation Factory allows entrepreneurs to launch their concepts more quickly and with more resources.

The network accelerates social innovation by providing support to enterprises and entrepreneurs financially and otherwise, and has RRI embedded in its operations: open to all and promoting positive social impact with a transparent business model characterised by reflexivity and responsiveness. This case also shows that RRI do not need to contradict the needs of business.

VINNOVA: CHALLENGE-DRIVEN INNOVATION

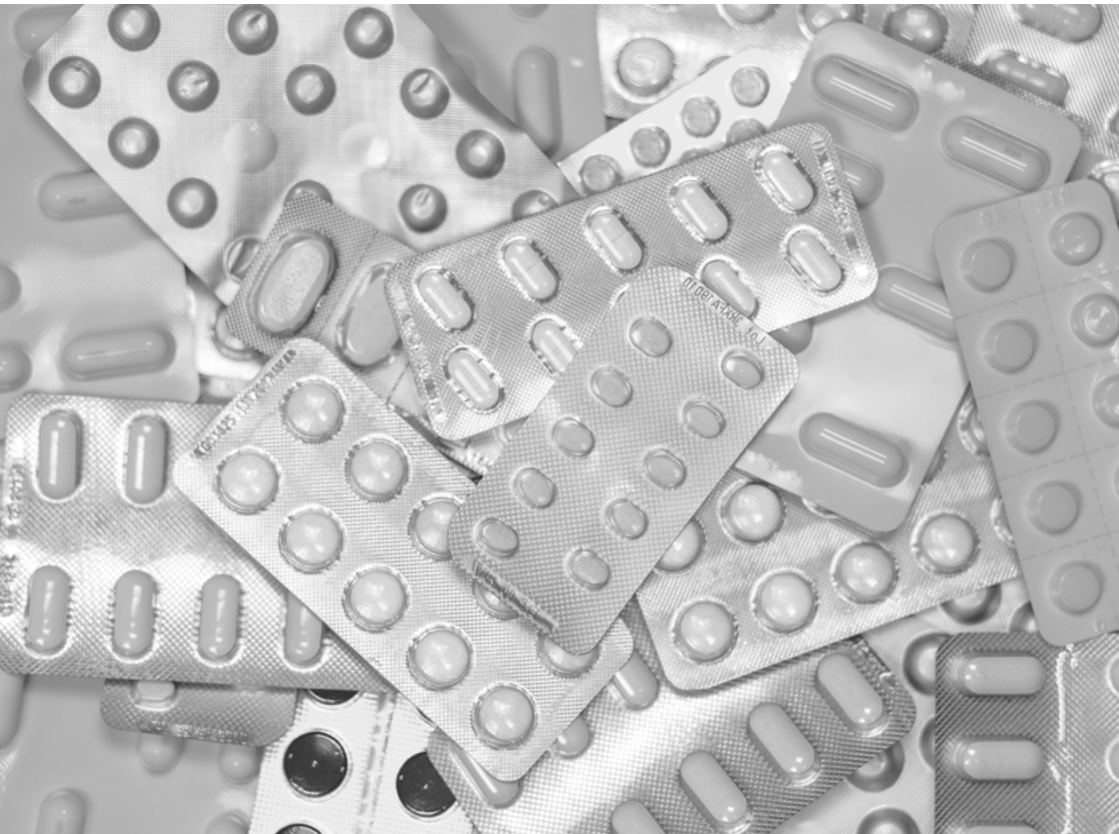
Sweden is in the top 20 countries for research spending — devoting over 3 percent of its GDP to the endeavour. Clearly, this is a society that values science and research. In 2014 alone, investment in research and development totalled over €40 billion. More than €2 billion of this was provided by the Sweden's innovation agency, Vinnova, which promotes sustainable growth by funding needs-driven research.

But in a 2007 internal review, the agency was found not to be fulfilling its mission and so it was tasked with developing a new strategy. Soon after came the Lund Declaration, which called on Europe to

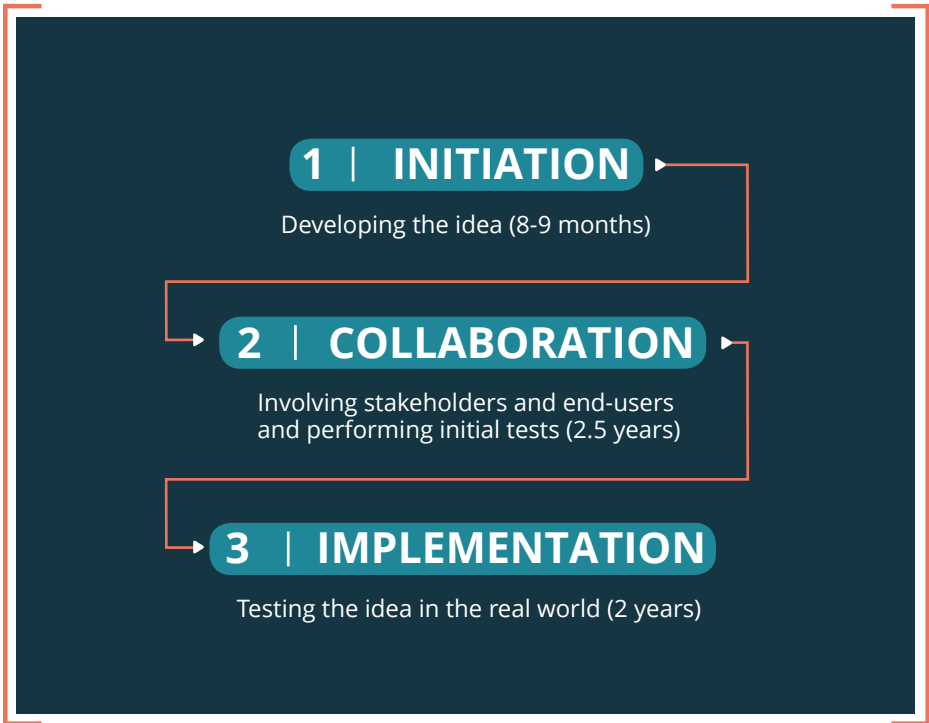
focus research on the 'grand challenges' facing society. This prompted the agency to push the following challenges to the top of its agenda:

- **An information society**
- **Sustainable, attractive cities**
- **Future healthcare**
- **Competitive production**

The agency developed a new 'challenge-driven' programme to fund projects in these areas. This programme addresses critical needs in society and involves cross-sector collaboration — in line with some of the major principles of RRI.



Challenge-driven innovation: the three stage process



Several projects are already underway. Currently in stage 2 is the 'School for everyone' project. This aims to help foreign students integrate into society by providing digital solutions for learning Swedish.

Already in implementation is Smedpack, a project funded under the 'Future Healthcare' bracket. This project seeks to tackle the growing problem of counterfeit drugs — fake medicines designed to mimic authorised ones — by involving over 30 partner organizations through the whole supply chain to create more secure phar-

maceutical packaging and help consumers detect dangerous fakes.

As well as inspiring successful projects in each of its key funding areas, the new approach to innovation has inspired change across the agency. Throughout Vinnova, collaboration between experts has increased, as has input from the public; other funding programmes have become more challenge-orientated; and entirely new programmes have been established, such as the Social Innovation programme, which focuses on initiatives for public benefit.

XPLORE HEALTH: EXPLORING SCIENTIFIC CAREERS THROUGH INNOVATIVE EDUCATION

Some subjects at school are always more popular than others. Physics, mathematics and engineering are often seen as more challenging than languages or humanities. Indeed, there is a concerning lack of students studying Science, Technology, Engineering and Mathematics (STEM) subjects at school, and even fewer going on to higher education.

A recent [Scientix report](#) on STEM education in Europe found that several countries suffer from a shortage of qualified STEM teachers, and that most European countries report a low number of students interested in studying or pursuing a career in STEM fields. Furthermore, they found that 80 percent of countries' school education systems were unaware of the concept of RRI.

Changing this will ensure society has the trained individuals it needs to solve complex problems, but also strengthen the relationship between science and society – a key element of RRI. Improving scientific education and making scientific careers more attractive for young people will nurture the researchers of the future. It will also create informed citizens equipped with the skills and knowledge to engage with science and to make informed decisions.

The European [programme Xplore Health](#) is working towards these goals; it is bridging the gap between education and research with its innovative educational approach. The programme provides multimedia resources, research related activities, and educational tools to help students consider the ethical, legal and social aspects of science.



The key elements of Xplore Health

Virtual experiments that allow students to understand what real research is like.

Games that encourage students to learn about research and its governance.

Videos in which researchers explain their projects in simple terms.

Outreach programmes such as events with professional scientists where students participate in research projects.

Through these activities Xplore-Health aims to:

- Bring science education closer to real research
- Promote innovative educational approaches
- Inspire future researchers
- Provide citizens with the skills they need to engage with and make decisions about research and innovation.

One of the outreach programmes of Xplore Health facilitated a participatory research project called 'Healthy Minds', where students chose the topics (mental health) and built the research agenda. Projects were then designed and implemented in collaboration with both researchers and students.

This case study clearly demonstrates the merits of high quality science education and also many of RRI's founding principles, including collaboration between social actors (such as researchers and the students), reflection on the ethical, legal and social aspects of research, and public engagement.



RRI Tools in short



Consultations on RRI

2014



Consultations

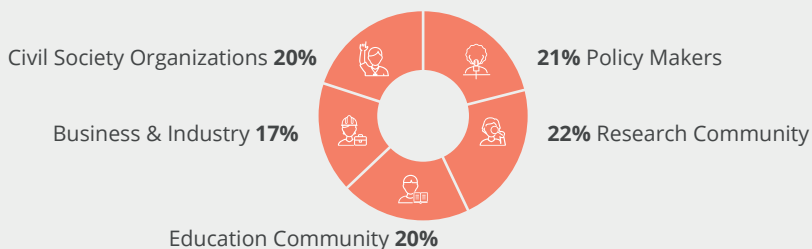


European Research Area countries covered



Participants

Participants



A common RRI definition

Responsible Research and Innovation is a dynamic, iterative process in which all stakeholders in research and innovation become mutually responsive and share responsibility for both the process and its outcomes.

Actions identified to strengthen RRI

	POLICY MAKERS	RESEARCH COMMUNITY	EDUCATION COMMUNITY	BUSINESS & INDUSTRY	CIVIL SOCIETY ORGANIZATIONS
Build a community of practice for collaboration among all actors and public involvement	✓	✓	✓	✓	✓
Promote specific communication, education and training on RRI	✓	✓	✓		✓
Align research practice, funding and organisation strategies towards RRI	✓	✓			✓
Remove obstacles to RRI and help financing markets and models based on it				✓	



Report on the analysis of opportunities, obstacles and needs of the stakeholder groups in RRI practices in Europe

RRI Tools in short

The RRI Community and the Toolkit

2015-2016

The RRI Community

900+

Members in the
Community of Practice

100+

Posts on RRI and related
topics on the **Blog**

5,000+

Followers on **social media,**
newsletter & forum

The RRI Toolkit

450+ **Resources** available and counting...



100+
Tools



35+
Inspiring practices



50+
Projects



270+
Background materials

Landing pages with tailored info on RRI according to:

5 Profiles



POLICY
MAKERS



RESEARCH
COMMUNITY



EDUCATION
COMMUNITY



BUSINESS
& INDUSTRY



CIVIL SOCIETY
ORGANIZATIONS

6 Interests



ETHICS



GENDER
EQUALITY



GOVERNANCE



OPEN
ACCESS



PUBLIC
ENGAGEMENT



SCIENCE
EDUCATION



What is RRI?
indepth page



28 Application guides
(**How Tos**)



**Self-Reflection
Tool**



50+ **Training resources**
(modules, showcases...)



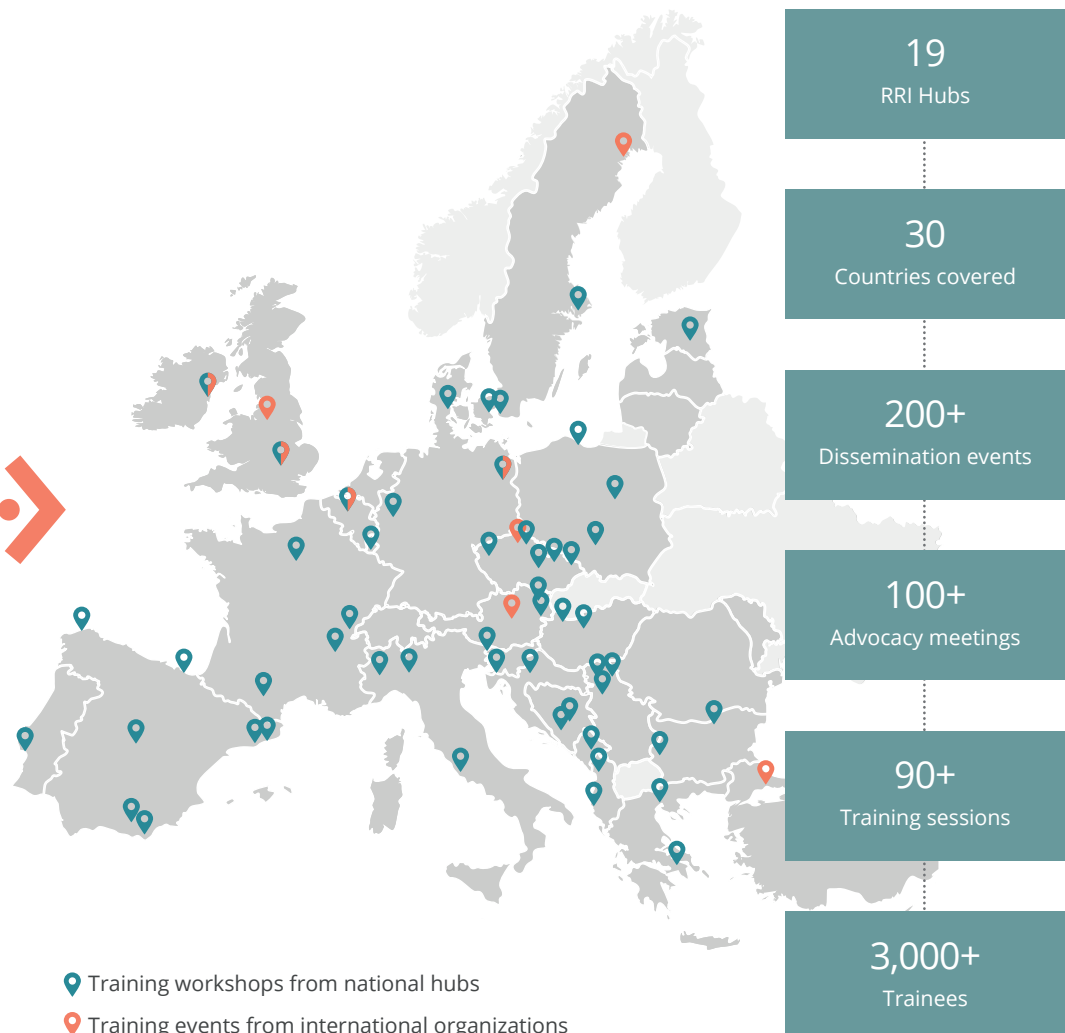
30+ **Communication resources**
(leaflets, videos, presentations...)



Don't wait, **join the RRI community** and play your part!

Communicating and Training on RRI

2014-2016



Dive into RRI: discover our fully adaptable **training modules, sessions and resources**



THE RRI TOOLKIT STRUCTURE

The RRI Toolkit contains a wealth of resources aimed at assisting users on learning, implementing, reflecting, training, and communicating responsible research and innovation. These resources — from academic literature to best practices and practical tools for implementation — have been developed by multiple initiatives, as well as by the RRI Tools project, and tackle a diversity of topics.

The Toolkit can be used by people with varying levels of expertise, from those who are complete newcomers to the concept to those that are already implementing it. Here are the major ways people can access and use the RRI Toolkit:

1. LANDING ON RRI

Anyone interested in RRI has a great starting point at the 'Landing on RRI' section. These five dedicated pages offer a crash course on RRI for the main groups of R&I actors: policy makers, research community, business, education community and civil society. These introductory pages outline what RRI means in simple terms, addressing the main needs and concerns of each group in their own language. Each tailored page contains a selection of recommended resources from

the Toolkit and links to the implementation guides described in the next section.

For those already familiar with some of the RRI policy agendas, there are six dedicated pages that link the holistic view of RRI with each of them: ethics, gender equality, governance, open access, public engagement and science education. These pages helpfully define and explain each of these agendas, how they can be implemented, and offer a selection of related resources from the Toolkit.

As a complement, the '[What is RRI?](#)' page, under the same section, provides a more in-depth explanation of the concept and its development, as well as links to further readings.

2. IMPLEMENTING RRI

Once users are au fait with the concept of RRI, they can learn how to implement it using the '[How To Apply RRI](#)' section of the Toolkit. There they will find 28 guidelines that explain how to put in practice RRI when dealing with those challenges faced by the R&I actors. These guides offer examples of current practices and explain how different resources of the Toolkit can be used to address these challenges.

When looking for specific resources — be they tools, case studies, projects or library elements — users can access the [search engine](#) to make customizable searches through its multiple filters and sorting options.

3. REFLECTING ON RRI

Reflection is a key element of RRI. The [Self-Reflection Tool](#) assists users in this process. This tool is not an evaluation one, but a way to spark a deep reflection on the user's current research and innovation practice, providing with a set of open questions to guide the analysis on how such practice can be made more responsible. For this reason, the tool can be used before, during, and after a concrete project or practice, allowing for continuous development.

Questions are organized under the six policy agendas but are developed based on the process dimensions that lie at the heart of the RRI approach ([see section Shaping the future](#)). After submitting their answers, users receive a personal self-reflection sheet summarizing their answers and a blank development plan to help them continue with the process.

4. TRAINING ON RRI

To spread the word on RRI, the Toolkit also contains a range of [training resources](#) that users can adapt to deliver their own training on RRI. This comprises three key modules — explaining RRI, why RRI is important, and how to use the RRI Toolkit — as well as eight showcases, which describe in great length RRI in practice. Each module provides exercises and further materials (videos, presentations, games) to develop participatory trainings on the different modules' topics.

For those who would prefer externally delivered training, during 2016 RRI Tools is offering more than 90 workshops to train a range of stakeholders in research and innovation across Europe, helping them to make sense of the RRI concept and how it could be useful to them.

5. COMMUNICATING RRI

Communicating the benefits of RRI beyond the current community of practitioners is key to increase the understanding and implementation of this approach. The final pillar of the RRI Toolkit comprises resources dedicated to circulating the concept of RRI more widely. This includes a [media room](#) full of communication materials — from press releases to posters —, a [forum](#) where members of the RRI Community can get together to discuss hot topics in and around RRI, a regularly updated [blog](#) with articles on the latest news and opportunities, and a search engine for the growing [RRI Community of Practice](#), with currently around 1,000 members. Members can be searched by name, institution, group (e.g., researcher or policy maker) and interest (e.g., gender, ethics, open access) allowing users to find exactly the contact they need, such as a potential partner for a new project or an expert in a particular field.

The RRI Toolkit: its key elements

The Toolkit now includes over 450 resources developed both by reputed experts in their fields and by RRI Tools. These resources are classified as:



Tools: Practical advice, manuals and guidelines to help put RRI into practice

Example: Toolbox for User Driven Innovation and Living Labbing

The Toolbox provides tips for how best to involve users in innovation, such as discover what users want and to develop concepts with consumers. Resources include details on theories and methods as well as checklists and handbooks.

http://www.rri-tools.eu/-/toolbox_user_tools



Inspiring practices: RRI success stories from across Europe

Example: VOICES

The VOICES project aimed at identifying the ideas, values, needs and expectations of citizens on urban waste, key to sustainability research in Europe by involving 1,000 citizens from 27 countries. The resulting reports suggested ways to improve the EU research agenda, draft research calls under Horizon 2020 and gave valuable insights on citizen participation.

http://www.rri-tools.eu/-/voices_insp_practise



Projects: A range of projects addressing RRI values

Example: GENDER-NET

GENDER-NET aims to encourage European countries to modernise their institutions by implementing gender equality initiatives and improving recruitment and career paths for women in science.

http://www.rri-tools.eu/-/gender-net_project



Library: articles, analyses, reports and more on RRI.

Example: Winning Horizon 2020 with Open Science

Open science can transfer knowledge to society, improve the quality of research, promote innovation (by connecting researchers with new collaborators) and increase return on investment. This report focuses on evaluating research based on its societal impact and provides tips for communicating it.

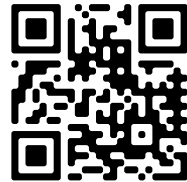
http://www.rri-tools.eu/-/winning_h2020_library_elem



TO FIND FURTHER INFORMATION ON THE TOOLKIT DESIGN, STRUCTURE, AND CONTENT CHECK THE RRI TOOLKIT REPORT.



HANDS ON: HOW TO IMPLEMENT RRI



RRI is a vast concept. Some groups — policymakers for example — may place more importance on certain parts of RRI than others such as scientists, innovators or civil society. So, to help guide all these different groups, the RRI Toolkit includes a series of ‘How To’s’, which explain how to apply RRI concepts and strategies in specific situations. The How To’s provide examples of what others have done, and how the different resources of the Toolkit can be used in different contexts.

This section only describes a selection of these How To’s. Besides these ones, many others can be found at www.rri-tools.eu/how-tos.

There are guidelines for:

- **Policymakers**, such as how to implement RRI on a national scale.
- **Researchers**, such as how to embed RRI in citizen science.
- **Educators**, explaining how to incorporate RRI at different education levels.

- **Business and industry**, such as responsible criteria for investors.
- **Civil society organisations**, such as how to design a R&I project proposal.

There is also advice for specific aspects of RRI, including:

- **Ethics**, such as how to promote research integrity.
- **Gender equality**, including guidance on creating gender-sensitive research contents, teams and decision bodies.
- **Governance**, such as how to create structures for implementing RRI.
- **Open access**, such as how to incorporate open access into research practice.
- **Public engagement**, such as how to foster multi-actor engagement.
- **Education**, such as how to introduce RRI in inquiry-based education projects.



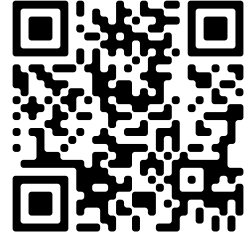
HOW TO INCORPORATE RRI IN POLICY OR FUNDING INSTITUTIONS

Government departments, research councils and private foundations are all critical to the research and innovation process. They fulfil various functions, from setting policy agendas and providing leadership in the R&I community to engaging the public in the research process and ensuring that innovation meets society's needs.

Clearly, if policy institutions and funding bodies are to embed RRI in their work, they must first be aware of and understand it. The RRI Toolkit helps those at the higher levels, such as management, to become more familiar with the concept. This then means they can act as advocates for RRI in their own institutions. For this purpose the Toolkit includes a short leaflet and video from the European Commission explaining what RRI means, as well as diverse dissemination materials produced by the project itself.

It is also important to embed RRI principles at the broader, institutional level. Capacity-building projects provide a

great example of how to achieve this, such as [PAC-ITA](#), a four-year EU effort to promote knowledge-based policy on issues involving science and innovation, focusing on interactive practices that involve all stakeholders.



Perhaps most importantly though, policymakers and funders need to be aware of what can happen when RRI is not applied. A plethora of examples can be found in the [European Environment Agency's Late Lessons from Early Warnings](#) series. Crucial reading for policymakers working in science and technology, the reports outline the negative consequences of irresponsible policy on society, citing examples from asbestos to pesticides. It contains important lessons for more precautionary and responsible decision-making.



Advancing the major RRI policy agendas

We offer one key resource for each of the RRI's six key policy agendas, which will help policymakers and funding bodies to advance these agendas:



ETHICS

The US Office of Research Integrity, which includes guidelines on avoiding misconduct and plagiarism in research.

<https://ori.hhs.gov>



OPEN ACCESS

The courses from the project FOSTER provide e-learning tools to help implement open science.

<https://www.fosteropenscience.eu/courses>



GENDER EQUALITY

The European Commission's plan for supporting structural change towards gender equality provides advice for this at all stages of the research process.

http://ec.europa.eu/research/swafs/pdf/pub_gender_equality/vademecum_gender_h2020.pdf



PUBLIC ENGAGEMENT

The UK's National Coordinating Centre for Public Engagement 'Planning for Change' website explains how to create structural changes for public engagement.

<https://www.publicengagement.ac.uk/support-it/planning-change>



GOVERNANCE

The EPSRC's framework for responsible innovation provides a scheme for including RRI principles in research.

<https://www.epsrc.ac.uk/research/framework/>



SCIENCE EDUCATION

Materials produced by the HEIRRI project are aimed at integrating RRI in various levels of higher education, from undergraduate to doctorate degrees.

www.heirri.eu



HOW TO SET UP A PARTICIPATORY RESEARCH AGENDA

A participatory research agenda, which involves all stakeholders, helps to identify the needs of communities and end-users, facilitates collaboration and means everyone's voices are heard.

There are many examples of participatory research, from initiatives to get patients involved in researching their own care (such as the UK [James Lind Alliance](#), which promotes dialogue between patients, doctors and researchers) to those involving farmers in agricultural research (such as the [Centre for Coordination of Agricultural R&D for Southern Africa](#), which regularly organises meetings between farmers, policy makers and researchers) – but how does one actually develop a participatory research agenda?

THE DIALOGUE MODEL

One common and successful model to engage stakeholders in setting the agenda is known as the [Dialogue Model](#). Although most often used to engage patients in healthcare research, this method can be used to engage stakeholders in any field.

The RRI Toolkit presents a five-step adaptation of the Dialogue Model to develop participatory research agendas:

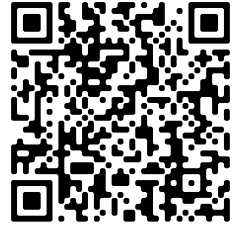
1) EXPLORATION

First, an analysis of stakeholders allows to identify and understand the different groups, organisations and individuals that should have a say.

2) ENGAGEMENT AND PRIORITISATION

Next, interviews and focus groups can help to understand the various issues at

stake. It is then important to choose which of these issues are the most important. For this, the [Delphi Technique](#) can be useful — an iterative method of group communication used to reach a consensus — or even just a simple online survey.



3) INTEGRATION

Once identified, the most important issues should be combined into a cohesive agenda. This involves meetings, which should include equal numbers of representatives from each group and avoid overly technical language, which can be alienating.

4) PROGRAMMING

This is about developing a research plan based on this agenda. It is once again crucial that stakeholder groups stay engaged with the process, perhaps by assigning them positions on programming committees.

5) IMPLEMENTATION

Finally comes implementation of the research plan, which could mean developing a proposal for funding or simply identifying a group to carry out the research. One of the biggest challenges in this process is making sure that all stakeholders are kept engaged, even in the very final stages. Involving them in committees and advisory boards can help to avoid the tendency to return to business-as-usual procedures.



HOW TO INCORPORATE RRI PRINCIPLES IN A FUNDING CALL

Including RRI in funding schemes is key to ensuring that research is innovative but also ethical, sustainable and acceptable for society. For funders aspiring to develop policies that are in line with RRI principles, they can act in the three major stages of the process:

A) Defining the funding call

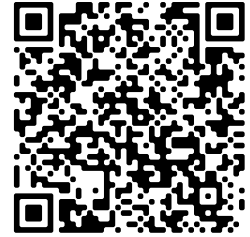
Before goals are set, funders can establish their priorities by talking with all stakeholders. Involving them makes sure that research is targeted at genuine societal needs.

B) Setting criteria and guidelines

One of the most obvious ways that RRI outcomes become part of the funding process is through rules that applicants must adhere to in order to receive funding. This can be applied either before the experiments even begin (for example, by stating that researchers must gain the approval of an ethics committee) or through rules that must be followed while a study is carried out. Some funding agencies even selectively integrate RRI as part of targeted projects and programmes, such as the [European Foundation Award for Responsible Research and Innovation \(EFARRI\)](#), which offers cash prizes to researchers that successfully address responsible principles in their work.

To help applicants meet these requirements funders can provide tailor-made guidelines. Some good examples include the [Wellcome Trust's Guidelines on Good Research Practices](#) and the [EPSRC Framework for Responsible Innovation](#), described in the [Showcase section](#). RRI Tools unlocks a wealth of information and

resources to help funders develop entirely new guidelines, such as the [Self-Reflection Tool](#), which can help identify which aspects of RRI are most important for them (see previous section).



C) Evaluating the proposal

When assessing research proposals, it can be helpful to use a jury of experts familiar with both the field of research and RRI. It can also be beneficial to involve other stakeholders in the evaluation process, but it remains important that other scientists review the proposal. Some key elements to include in the review process are outlined in the [European Peer Review Guide](#) and include excellence, transparency and ethics. When evaluating the RRI aspects of the proposal, the peer review process should also consider how inclusive the work is and whether sufficient effort has been made to engage stakeholders from outside academia, to anticipate unexpected impacts or to adapt to external changes. Additional criteria to discuss and evaluate a research or innovation proposal or process can be found in the RRI Tools [Report on the Quality Criteria of Good Practice Standards in RRI](#).

Lastly, for research to have maximum impact, the evidence must be in the hands of those with the power to change things. [The Research Uptake](#) guide published by the British government offers some useful advice on how to communicate the results of research to policymakers.



HOW TO DESIGN AN RRI-ORIENTED PROJECT PROPOSAL

Whether mentioned explicitly or alluded to with terminology such as ‘ethical acceptability’, ‘sustainability’ or ‘social desirability’, RRI is increasingly featured in funding calls. It is pervasive in the EU’s [Horizon 2020](#) Framework Programme as well as in national funding schemes throughout Europe in countries such as Norway, the Netherlands and the UK. The approach is also spreading further afield, with similar initiatives in Australia, the US and parts of Asia.

Researchers around the world are thus asking: how do I embed RRI in my research proposal? To improve the chances of obtaining funding, they should consider:

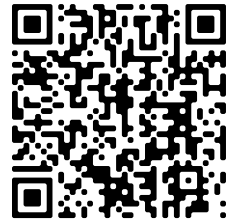
ETHICS

Ethical research is done with integrity, consideration for the ideas and concerns of others, and alignment with social values. To achieve this, applicants should follow standards, guidelines and protocols, which could be national, local or set by the funding body itself. They usually focus on the following key areas: research involving humans and animals, informed consent, and data protection and confidentiality. There are various tools to help comply with ethical guidelines, such as the [European Code of Conduct for Research Integrity](#) and [KARIM’s Introduction to Responsible Innovation Criteria](#) — a more practical guide to responsible innovation.

GENDER EQUALITY

Gender is an important consideration for all research, especially in medical

science. When drugs are developed it is essential that testing is carried out on both female and male participants to determine efficacy and side effects for both. Scientists in all fields should show that they have considered the gender dimension in their research and strive for gender equality when building their teams.



OPEN ACCESS

Providing free access to research data, methods and results is an increasingly prominent feature of funding calls. Publishing articles in traditional academic journals is still the main method of communicating research, but several alternative opportunities are emerging — such as publishing under a [Creative Commons](#) license — and considering them may help proposals to be funded. Going beyond open access, the guide [Winning Horizon 2020 with Open Science](#) explains how to embed open science through project proposals.

PUBLIC ENGAGEMENT

Researchers are now being asked not only to provide their results to the public, but also to actively engage with them through the whole R&I process. Applicants need to include in their proposals activities that involve the public. A useful tool for this purpose is Engage2020’s [Action Catalogue](#) — an online system to help actors find the best participatory methods for their projects.

SCIENCE EDUCATION

Education is not usually a part of funding calls, but some programmes do have requirements for it. Although not a mandatory element of RRI, it may be worthwhile considering some training activities in the 'impact' section of a

proposal — perhaps creating an exhibition with the results, involving a local school in data collection, or even introducing students to some of the real intricacies of the research process through project-based education activities.

PUTTING IT ALL TOGETHER

While these individual elements are each important, a robust proposal should embrace RRI holistically, as an entire concept. In practical terms this means RRI principles should be present throughout the proposal:



BEING RESPONSIBLE

Values of honesty, fairness, objectivity, reliability, accountability and openness are essential.

ENGAGING ALL STAKEHOLDERS

Policy makers, business, civil society, educators, and end users are all key players to develop societally relevant R&I. The [Dialogue Model](#) can be used to engage with users in the planning stages of the research, while several online resources can help engage actors during it, such as the [Participatory Methods Toolkit](#).

INVOLVING MULTIPLE DISCIPLINES AND SECTORS

A multi-disciplinary approach enables beneficial collaborations and combines different perspectives — both key requirements of RRI.

ASSESSING IMPACT

It is important to measure and consider the broader social, ethical and environmental implications of the proposal. The UK Research Council's tool [Pathways to Impact](#) may be useful here.



HOW TO EMBED RRI PRINCIPLES INTO A BUSINESS PLAN

With calls for responsible businesses growing, the RRI Toolkit provides tips to guide start-ups and Small- and Medium-sized Enterprises (SMEs) by implementing RRI. First, businesses have to be convinced to make the effort.

As well as considering profit, businesses should think about environmental and social impacts. They should also consider how they function internally, whether they have a gender-balanced board, and how they treat their customers. Corporate social responsibility is an important part of running a business, but what's in it for the businesses themselves?

As well as creating a better world, acting responsibly can be beneficial for businesses. Including responsible innovation in processes and products provides competitive advantages, including cost reductions, increased sales, reduced risk, improved reputation and better relationships with investors, employees and governments.

The [KARIM](#) project offers an introduction to RRI for businesses. Other resources are available via the [Responsible Industry](#) project, the Business and Industry section of the [Responsibility Observatory](#) and the Responsible Innovation [online course](#).

RRI should be considered from the start of business projects. This means considering the environmental, social and economic implications and planning for any adverse impacts. The first step for many is complying with regulations, such as EU [data protection rules](#) and new standards to certify responsible behaviour.

When developing any RRI-focused business plan, the first step is identifying the societal challenges they are aiming to address and the added



value that the proposed solution presents to the problem. At this stage, the [Social Innovation Journey Toolbox](#) can be useful to help enhance the social impact of projects.

In developing new products and services, consumers' concerns should be carefully considered, as well as the long-term impacts that the products may have. There are various methods of assessing these impacts, such as the [KARIM Responsible Innovation Criteria and Grid](#), which contains standards to measure the social, economic and environmental impacts associated with a project.

Thirdly, it is key that businesses innovate openly and involve stakeholders in the process. This is critical to achieve ethically acceptable, sustainable and socially desirable business. Tools such as the [Participation Compass](#) and the [Participatory Methods toolkit](#) can help businesses to choose the right method for engaging with their stakeholders.

There are various resources to incorporate all of these elements into a business plan, including the [Social Innovation Journey Toolbox](#), which provides a helpful template for a social business model. For more inspiration, check out the [Social Innovation Factory](#), an accelerator network that supports businesses to create products and services providing answers to societal challenges and demonstrating how RRI can promote business success.





HOW TO CO-CREATE COMMUNITY-BASED PARTICIPATORY RESEARCH

Public engagement is a central element of RRI. One way of achieving this is through Community-Based Participatory Research (CBPR), a partnership approach that involves community members in the research process, including contributing expertise and decision making. Instead of making communities the subjects of research, CBPR makes them active participants in research. The knowledge and understanding gained through CBPR is often linked to real change — be it an intervention or policy change — that improves quality of life. This approach has clear benefits for communities, empowering them to investigate and change their own situations. Yet there are also many advantages for researchers, including the use of existing resources (such as local knowledge) to drive research, which gives credibility to a project and brings diverse skills and expertise together to solve difficult problems.

Many projects demonstrate these benefits, including [Xplore Health](#), an educational project bringing together students and researchers covered in the [Showcases section](#) of this report, and [PERARES](#) (Public Engagement with Research And Research Engagement with Society), a project that brought together researchers and members of the public to discuss and develop new research projects.

Once convinced of the merits of this approach, how does one implement it? An important starting point is identifying the methods through which the community will be engaged. There is a wide

range of participatory methods available, but all should allow the public to play an active part in decision-making.



The [Participatory Methods Toolkit](#) offers practical advice on finding the right method for your particular situation, while the [Participation Compass](#) allows users to search methods of participation both by purpose and funds available. Similarly, the [Action Catalogue](#) contains over 50 methods of public engagement, separated by reason for use, groups involved, public involvement level and the challenge being addressed.

Some particularly powerful methods of involving communities in research include giving them specific roles in a research project — this is part of the [citizen science](#) movement. Workshops in which experts present [scenarios](#) to local communities can also be useful for co-developing strategies and research plans. This method is used by international organisations including the EU and the United Nations.

There are many resources available to help develop community-based research, from handbooks on engagement to guidelines on evaluation. Some good starting points include those outlined above plus the toolkits and manuals available via the [Community-Campus Partnerships for Health](#) and the [Living Knowledge](#) websites.



HOW TO INTEGRATE RRI IN SECONDARY EDUCATION

High quality science education is essential to fostering RRI, providing students with the necessary skills and competencies to engage with current S&T developments and ultimately to become responsible citizens. Including RRI principles in secondary education ensures the learning of important skills like critical thinking, which prepares students to make informed decisions in the future.

This does not need to be a complex and time-consuming task. Basic RRI concepts can be easily introduced in common classroom activities. For a few minutes at the end of each class students could be asked to discuss how what they have learnt relates to RRI principles, such as diversity or ethics. In group projects students could be given time to consider how they carried out the project. For instance, reflecting on the processes used or on the results produced will teach them how to carry on reflection. Likewise, asking them to make changes in their strategies and methods will introduce them to the adaptive change principle.

To facilitate these sessions, teachers could consider using reflection and discussion games such as those described in [The Systems Thinking Playbook for Climate Change](#) or in [Play Decide](#) — a discussion game that encourages dialogue about controversial issues such as animal testing and climate change.

Whichever way teachers decide to go about it, it is vital to link the principles of RRI to concrete examples. Ideas for achieving this could be taken from the [Xplore Health](#) and [ENGAGE](#) projects, which provide adaptable lesson plans and activities.



It is also important to make sure classroom activities are collaborative and involve diverse student groups. This can help to nurture open and inclusive behaviours in students. An example of activity could be organising an exhibition centred around the results of a recent research project, inviting school staff and students, parents, representatives of the local community and even experts on the topic.

The [IRRESISTIBLE project](#) offers specific tips for promoting collaboration between schools and science museums and for creating exhibitions around RRI. For more general recommendations on improving science teaching, educators can check out the resources of the [DESIRE](#) (Disseminating Educational Science, Innovation and Research in Europe) project, set up to improve STEM education in schools across Europe. Both projects provide useful information for creating multidisciplinary and collaborative educational activities embedded in RRI.



HOW TO INCORPORATE RRI IN SCIENCE ENGAGEMENT ORGANISATIONS

Science engagement organisations, such as science centres and museums, already put into practice many of the key tenets of the RRI approach. They not only make science interesting and engaging for citizens, they also promote scientific careers and provide people with the knowledge and skills they need to take part in conversations around science and technology, encouraging people to be more critical of science.

However, there is scope for expanding the use of RRI in their activities, and the RRI Toolkit offers many resources to science engagement organisations wanting to benefit and participate in the RRI processes. Below are just a few examples of RRI resources to get you inspired!

GETTING UP TO SPEED

If you are getting started, try the introductory video to [Science Education](#) or [Public Engagement](#). The [DESIRE Toolkit](#) can be useful for planning and implementing dissemination activities of the science education projects. You also might want to check out the open access [Journal of Science Communication](#) to learn about the latest research in the field. Or check out the SPARKS project aimed at spreading the word on RRI through a touring exhibition in science centres and museums across 29 European countries.

CITIZEN SCIENCE

For organisations engaged in citizen science, the [Citizens Create Knowledge](#) project can provide plenty of inspiration on developing citizen science, while the [User's Guide for Evaluating Learning Outcomes from Citizen Science](#) provides a tool to measure the impact of such activities. More specific resources on citizen science can be found [here](#).



GENDER

The [TWIST Guidelines](#) targeting mostly science centres and museums will help to reflect on how to incorporate gender perspectives in exhibitions and activities. Criteria for gender inclusion developed by the Hypatia project will help to reflect and act about unconscious gender assumptions. The criteria propose a way of tackling this gap on 4 different levels: Individual, institutional, societal and global.

EVALUATION

The [Evaluation Practical Guidelines](#) will also help you to develop an evaluation framework for public engagement activities. Due to their roles as 'intermediate agents' promoting dialogue between different stakeholders, science engagement organisations can position themselves as active shapers of RRI.



HOW TO INCORPORATE RRI IN HIGHER EDUCATION INSTITUTIONS

As the educators of the next generation of scientists, innovators, policymakers and CEOs, universities and other higher education institutions have a key role to play in shaping society. They have the power to promote RRI by training students in the principles of RRI, and can help to ensure that future R&I is ethical, socially desirable and sustainable.

The RRI Toolkit provides a number of resources that can help make this a reality. To embed RRI at the institutional level, the project recommends developing:

- 1) A framework of RRI principles, such as those described in the [RRI Tools Policy Brief](#) and the [EPSRC Framework for Responsible Innovation](#).
- 2) Plans to promote discussion, reflection and public engagement, which can be assisted by the [Sciencewise Departmental Dialogue Index](#), and gender equality, which could be backed up by the [GenisLab guidelines](#) for institutional change.
- 3) An ethical code of conduct for research and teaching, such as the [Code of Practice and Procedure](#) developed by Oxford University.
- 4) Policies to promote open science, including making scientific results accessible. The [How to Implement Open Access Policies at Institutions](#) section in the RRI Toolkit provides specific advice on this, including how to develop institutional policies on open access.
- 5) Courses to train students on RRI, such as the [Responsible Innovation: Ethics, Safety and Technology online course](#), produced by Delft University in the Netherlands.

Institutions could also consider running training courses for staff, on how to

identify scientific misconduct for example. [The Training and Resources in Research Ethics Evaluation \(TRREE\)](#) set of e-learning resources provides



useful guidance in ethical standards for research. There is also a wide range of resources available to train staff in how to use participatory methods (such as the Engage2020 [Action Catalogue](#)) and publish in open access formats (such as the [FOSTER open science training programme](#)).

But of course, the most important targets for fostering RRI are those who practice it: scientists. R&I teams should be informed on the requirements for RRI and the benefits of using these principles. Key areas to cover include the use of open access, considering a range of views and perspectives in their research, and the value of citizen science. More information on this can be found in the [How to Design an RRI-oriented project proposal section](#).

Finally, in order to nurture RRI in the next generation, universities should encourage professors and lecturers to include RRI concepts in their syllabus, perhaps by integrating key ideas – such as diversity and sustainability – throughout existing courses, or by developing specific modules on RRI. Helpful resources for educators include the [KARIM recommendations](#) for teaching responsibility in technology courses and the [EnRRich](#) and [HEIRRI](#) projects, which provide resources for incorporating RRI principles into higher education curricula.



5 GOLDEN RULES FOR ACHIEVING RRI

There is ample agreement on how to improve some aspects of research and innovation, such as incorporating ethics, research integrity, gender equality, open access, public engagement, and science education into the process. These elements are included as policies and recommendations in multiple R&I programs,

including Horizon 2020. But **practising responsible research and innovation goes well beyond these normative aspects.** Here are five key recommendations to achieve research and innovation that is more responsible both in its outcomes and its processes:

1. THINK ABOUT WHAT SOCIETY WANTS

Research and innovation should not just take place in society, but for and with society. Citizens should be thought of not only as the end users of science and technology, but as partners in its development. This implies science education needs to play a key role in educating the responsible citizens, researchers and innovators of tomorrow from the early stages to higher education. There are various strategies to embed RRI in education and to engage with the public in the planning, design and implementation stages of R&I – many of which can be found in the RRI Toolkit.

2. INVOLVE A WIDE RANGE OF STAKEHOLDERS AND SOCIETAL ACTORS

Responsibility needs to be shared among many different actors during R&I development. This not only allows the public a say on which and how research and innovation activities are conducted, but can also improve their outcomes by adding a wider range of expertise and perspectives, making R&I more socially acceptable and ultimately more relevant and impactful.

3. CONSIDER ALL POSSIBLE IMPACTS

Key to truly responsible R&I is anticipation — predicting as many of the potential effects of a project as possible, and not just those that are intended. Impact exploration should be in-depth, considering how the research and innovation might shape our collective future and what these changes might mean for society and the environment.

Linked to this is reflection, which means thinking about why research and innovation is being conducted, its goals and its implications. A key part of this deals with uncertainty, which is an understandably

inevitable part of R&I. There are various strategies and approaches used to account for uncertainty, such as scenario planning — a systematic way of thinking about the future.

4. BE OPEN AND TRANSPARENT

Being open about research and innovation is vital to build public trust. This means disclosing results, methods and data, and engaging in a transparent, meaningful and multiple-way dialogue with all relevant parties. This dialogue can foster social acceptance of R&I advances and lead to more robust outcomes.

Openness and transparency are particularly important features of RRI because they lay the foundations for accountability — making scientists and innovators answerable for their actions and the consequences. Open science also allows those who may not usually be involved in science and technology, such as members of the public or those working in business, to review research and innovation and make their opinions heard.

5. RESPOND AND ADAPT

Opinions are of little use unless they are acted upon. Therefore, the final recommendation is to change ways of thinking, working and, if necessary, entire organisational structures in response to feedback from society. As well as the views of society, it is also important to respond to the perspectives of other stakeholders, such as policy makers and those who commercialise R&I, for which active listening and an open mind are needed. It is also key to adapt to the emergence of new knowledge and changing circumstances, such as changes to the funding landscape.





MINDS ON, HEARTS ON: REFLECTING AND LOOKING AHEAD

After three years of work, RRI Tools presents its contribution to the fostering of the responsible research and innovation concept. Beginning as a grouping of 26 partners and 19 hubs across 30 European countries, it has contributed to building a Community of Practice nearing as of today 1,000 members worldwide and a Toolkit on RRI to assist everybody to apply this concept in practice.

Building upon previous efforts, the project has developed a working definition of RRI and created a catalogue of best prac-

tices to describe what RRI looks like in real life situations. Its collection of show-cases exemplifies how RRI can be carried out by businesses, governments, funding bodies, research centres, civil society and educational institutions.

RRI Tools has also explored the benefits of RRI for a wide range of stakeholders — from those closest to research and innovation to those regulating its implications, as well as those affected by these implications — while also characterising the barriers that could stand in the way of it.



As a result, the project has identified the actions needed to make RRI a reality and has crafted a Toolkit to help anyone who wants to make their research and innovation processes more responsible. The RRI Toolkit gathers over 450 resources developed by experts in a diversity of fields as well as by the project itself. These resources are useful for a number of goals, ranging from increasing awareness of RRI to implementing it and evaluating its outcomes. The accompanying How To's explain, step by step, how to use many of these resources to put RRI in practice in a range of situations for different actors. This is perhaps the most practical achievement of the project and will help

people across the globe to quickly find advice and support on RRI.

To further the RRI message, the RRI Toolkit also provides educational resources to help others develop their own training programmes, advocate and spread the word about this approach. This will help those who are new to RRI to make sense of the concept, understand how it can be applied and how it could be useful to their work. Finally, the creation of a growing, global RRI Community of Practice means people interested in RRI can engage through forums and networking events. This will ensure that the Toolkit continues to evolve and acts as a source

for the latest information on RRI in the future.

This future will undoubtedly bring changes. Science and technology are becoming more open, collaborative and connected than ever. R&I projects increasingly include a diverse range of partners and voices to plan, co-create and co-develop marketable solutions, adapt to social demands and anticipate unexpected impacts, transparently share knowledge and ideas with all actors, connect people and institutions in different disciplines, sectors and countries. This means we can better tackle the global challenges society faces, and use their results to openly inform responsive policies, future developments, and new educational approaches for a more knowledgeable society. This all resonates with RRI and puts its principles as cornerstones of the new science and technology trends.

These transformations are reflected in the three goals set by EC Commissioner Carlos Moedas for research and innovation in the EU: [Open Innovation](#), [Open Science](#) and [Open to the World](#). In contrast to classical closed innovation principles, Open Innovation is about sharing the knowledge of many different players to co-develop products and services that better meet society's needs. Open Science describes a whole new approach to the scientific process, based on new methods of doing research and sharing scientific knowledge, moving away from the traditional way of communicating research. Open to the World means promoting international cooperation in research and innovation, using the knowledge, talent and resources available worldwide to more effectively take on challenges that do not stop at national borders.

Summarised as the three O's, these goals share many similarities and are mutually supportive with the principles of RRI. All these elements will gradually feed into the shaping of a policy for Responsible Research and Innovation and contribute to putting citizens at the center of the attention of policy makers and R&I organizations, for example through citizen science activities and user-led innovations.

Whatever the future may be, RRI principles are now firmly established at the heart of the research and innovation system. RRI Tools has contributed to set the stage; others should capitalise on this work to ensure that the word continues to spread. As science and technology progresses at a faster pace than ever before, it is essential that responsible research and innovation is embedded in governance structures around the world to make sure these developments work for the society of today and tomorrow.



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